FUEL CELL SYSTEM AND METHOD FOR CONTROLLING THE SAME

Detailed Action

1. The amendments filed on June 22, 2010 were received. Applicant has amended claims 1, 2 and 9; and, cancelled claim 11. Claims 1-10 are pending.

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claim Objections

3. The objection to claim 11 is withdrawn because claim 11 was cancelled.

Claim Analysis

4. The analysis to determine if 35 U.S.C. 112, 6th paragraph has been invoked with respect to claims 1-11 as presented in the previous Office Action remains applicable and will continue to be applied in this Office Action.

Claim Rejections - 35 USC § 112

5. The rejection of claims 2-8 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention, is withdrawn because claim 2 was amended.

6. The rejection of claim 10 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention, is maintained. The rejection is repeated below for convenience.

Regarding claim 10, the claim recites "... a quantity of water generated in the cathode flow channel obtained by the generation in the fuel cell ...". In claim 9, the "cathode flow channel" is that "which a cathode gas containing oxygen is supplied". It is unclear how water can be generated prior to entry, and subsequent reaction within, the fuel cell.

Claim Rejections - 35 USC § 103

7. The rejection of claim 11 under 35 U.S.C. 103(a) as being unpatentable over Sederquist (US 4,128,700) in view of Yamashita et al. (US 2002/0031450) with withdrawn because claim 11 was cancelled.

8. Claims 1 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sederquist (US 4,128,700) in view of Yamashita et al. (US 2002/0031450) and Merritt et al. (US 5,441,821). Additional supporting evidence provided by Merriam-Webster's Online Dictionary.

Regarding claims 1 and 9, it has been held that, a preamble is generally not accorded any patentable weight where it merely recites the purpose of a process or the intended use of a structure, and where the body of the claim does not depend on the preamble for completeness but, instead, the process steps or structural limitations are able to stand alone. See *In re Hirao*, 535 F.2d 67, 190 USPQ 15 (CCPA 1976) and *Kropa v. Robie*, 187 F.2d 150, 152, 88 USPQ 478, 481 (CCPA 1951).

Sederquist teaches a fuel cell power plant including a fuel cell stack and a fuel conditioning apparatus composed of a reactor, which can be integrated with a burner and a heat exchanger, and a shift converter (Abstract; 2:66-3:4, 4:32-34; Fig. 1). Each fuel cell is composed of a cathode electrode spaced from an anode electrode with an electrolyte retaining matrix (3:6-8). The burner receives fuel cell anode and cathode exhaust and, after heating the gases, provides a portion of these gases (the burner exhaust) to the reactor (3:30-41, 3:51-52, 3:59-60, 4:14-15). Fuel for the reactor is added to the burner exhaust and

converted to hydrogen (Abstract; 4:15-17). Reformer exhaust has carbon monoxide removed in the shift converter and the resulting gas stream is delivered to a pump that feeds the fuel to the anode side of the fuel cell (4:26-31). A compressor provides air to the cathode side of the cell (3:30-31).

Sederquist does not expressly teach a cathode pump; or, a detecting means for supplied fuel quantity, supplied cathode gas quantity, and generated power quantity; or, a control device for controlling delivery of reform-subject fuel; or, the method steps as recited in the claim.

As to a cathode pump, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a pump to supply cathode gas through the cathode flow channel on the fuel cell system of Sederquist because the use of pump as a means to move reactants to (and from) a fuel cell system is well-known in the art; and, Sederquist teaches that the system is not required to be pressurized (see Sederquist, 4:60-61).

As to the supplied fuel and supplied cathode gas detecting means, it would have been obvious to one of ordinary skill in the art at the time of the invention to include flow meters into the fuel cell system of Sederquist to measure the amount of fuel or cathode gas supplied to the system because the use of these meters are well-known to those skilled in the art as means with which to accomplish this task.

As to the control device and the method steps, Yamashita teaches a control device that suitably heats reformate fuel, provided by a reformer to a fuel cell, so as to obtain high-quality reformate gas by stabilizing the temperature of a reforming portion regardless of load fluctuations (Abstract; para. 31). The reformer is composed of a heating portion, a reforming portion, and a carbon monoxide (CO) oxidizing portion (para. 31). The heating portion heats and vaporizes a reformate fuel with use of a combustion portion, such as a burner fed fuel and an oxidizing agent (e.g. air), and a vaporizing portion employing the heat generated by the combustion portion (para. 32, 39). The amount of reformate gas generated in the reformer (i.e., the amount of vapor mixture of reformate fuel generated in the heating portion) corresponds to the load applied to the fuel cell (para. 47, 48).

A control system receives detection signals from a air/fuel (A/F) ratio sensor (disposed at an end of the exhaust pipe of the heating portion); temperature sensors (detects the temperature from combustion of the reformate fuel and oxidizer); and, a current sensor (detects the load placed on the fuel cell), which are inputted to its electronic control unit (para. 40, 41, 43). The system determines the amount of reformate fuel needed to produce the hydrogen required by the fuel cell to meet the requirements of the detected load (para. 48). Then, the amounts of combustion fuel and oxidizer required to turn the reformate fuel into the needed reformate gas (i.e., the reforming reaction requirement), and an optimum (or target) air-fuel ratio (based on the temperature of the reforming reaction requirement), are determined (para. 71, 72, 73). In order to maintain the desired reaction temperature, which corresponds to a target air-fuel ratio, the amount of air or fuel provided to the combustion portion of the reformer's heating portion can be adjusted (para. 83-86).

Thus, it would have been obvious to use the control method described by Yamashita to control the fuel cell system of Sederquist, and include a control device in the system in order to perform the method steps, because Yamashita teaches that the method, employing the use of control device, allows the system to adjust the amounts of fuel and cathode gas provided to the fuel cell system in response to changes in load. Further, it would have been obvious to that skilled artisan to employ an ammeter as the current sensor used in the fuel cell system of Sederquist, as modified by Yamashita, because an ammeter known as an instrument for measuring electric current (see "ammeter" on Merriam-Webster's Online Dictionary).

Further, as to the determination of a residual oxygen quantity in the cathode offgas, Merritt teaches that, characterizing fuel cell systems employing re-circulated reactant streams, it is convenient to define the term "recirculation ratio" as the amount of a reactant supplied to the fuel cell stack divided by the amount of the reactant consumed in one pass through the fuel cell stack (3:27-29). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to calculate the residual

oxygen quantity in cathode offgas of fuel cell system of Sederquist, as modified by Yamashita, by subtracting the amount of oxygen consumed by a pass through the fuel cell from that supplied to the cell because Merritt teaches that characteristics of reactants re-circulated in the system can be determined comparing the amount of a reactant introduced to the cell and to that consumed by it; and, a skill artisan would appreciate that subtracting these two values produces the amount of reactant not consumed to the system (and re-circulated back to it).

9. Claims 2-8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sederquist (US 4,128,700), Yamashita et al. (US 2002/0031450) and Merritt et al. (US 5,441,821) as applied to claims 1 and 9 above, and further in view of Aoyama (JP 2000-195534 A; refer to JPO Abstract and machine translation).

Regarding claims 2 and 10, Yamashita teaches that the ratio of S/C (steam to carbon) is set to a desired value (e.g., about 2) (para. 48). However, Sederquist, Yamashita, and Merritt do not expressly teach a reformed water quantity calculation step.

Aoyama teaches a fuel cell system with a reforming part producing fuel gas used in a power-generating fuel cell (Abstract). Water discharged from the fuel cell is used to generate steam sent into, and used by, the reforming part (Abstract; machine translation, para. 17,24). If the amount of water produced by the fuel cell is insufficient to provide the steam required by the reforming part, a steam generation part will provide the additional steam needed (machine translation, para. 18). A control part 40 controls the amount of steam provided to the reforming part (machine translation, Claim 2, para. 26,38).

It would have been obvious to one of ordinary skill in the art at the time of the invention include a reformed water quantity calculation step in the method of Sederquist, as modified by Yamashita and

Merritt, because Aoyama teaches that a its use is a means with which to control the amount of steam provided to a reformer that used water generated by fuel cell operations.

Further, one would appreciate that the S/C of the fuel cell system of Sederquist, as modified by Yamashita, Merritt and Aoyama, is maintained in target range because Yamashita teaches that this ratio is set when determining the amount of reformate fuel needed to meet the requirements of detected load (see Yamashita, para. 48 and discussed above).

Regarding claim 3, as discussed above, Yamashita teaches that the system determines the amount of reformate fuel needed to produce the hydrogen required by the fuel cell to meet the requirements of the detected load (para. 48). Then, the amounts of combustion fuel and oxidizer required to turn the reformate fuel into the needed reformate gas (i.e., the reforming reaction requirement), and an optimum (or target) air-fuel ratio (based on the temperature of the reforming reaction requirement), are determined (para. 71, 72, 73). In order to maintain the desired reaction temperature, which corresponds to a target air-fuel ratio, the amount of air or fuel provided to the combustion portion of the reformer's heating portion can be adjusted (para. 83-86).

Regarding claim 4, the limitations recited in this claim has been addressed above in claims 1-3.

Regarding claim 5, Sederquist teaches a fuel cell power plant including a fuel cell stack and a fuel conditioning apparatus composed of a reactor, which can be integrated with a burner and a heat exchanger, and a shift converter (Abstract; 2:66-3:4, 4:32-34; Figs. 1, 2), as discussed above.

Further, as discussed above, Yamashita teaches that, in order to maintain the desired reaction temperature, which corresponds to a target air-fuel ratio, the amount of air (oxidizer) or fuel provided to the combustion portion of the reformer's heating portion can be adjusted. One of ordinary skill in the art would readily appreciate that controlling the amount of oxidizer supplied to reformer used in the method of Sederquist, as modified by Yamashita and Merritt, can either suppress, or increase, a burning reaction

used to heat the reformer as required by the requirements as determined by the optimum (or target) air-fuel ratio.

Regarding claims 6, 7 and 8, the limitations recited in these claims have been addressed above with respect to claims 1-5.

Response to Arguments

10. Applicant's arguments filed August 30, 2010 have been fully considered but they are not persuasive. In sum, applicant argues that none of the references teach the claimed oxygen quantity calculation step or carbon quantity correction step (see p. 10-12 of its remarks).

First, it should be noted that applicant's arguments do not comply with 37 CFR 1.111(c) because they do not clearly point out the patentable novelty which he or she thinks the claims present in view of the state of the art disclosed by the references cited or the objections made. Further, they do not show how the amendments avoid such references or objections. Second, it should also be noted that one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Finally, the method of controlling a fuel cell system as recited in the claims is taught by the combination of the Sederquist, Yamashita, Merritt and Aoyoma references as discussed in the rejections presented above.

Conclusion

11. The prior art made of record in the previous Office Action, Ikeda et al. (JP 10-144335 A), remains pertinent to applicant's disclosure.

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a)The prior art made of record in the previous Office Action, Ikeda et al. (JP 10-144335 A), remains pertinent to applicant's disclosure.

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Edu E. Enin-Okut** whose telephone number is **571-270-3075**. The examiner can normally be reached on Monday to Thursday, 7 a.m. - 3 p.m. (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Dah-Wei Yuan can be reached on 571-272-1295. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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